RECITATION 1

CH 2

•4 A car travels up a hill at a constant speed of 40 km/h and returns down the hill at a constant speed of 60 km/h. Calculate the average speed for the round trip.

$$s_{avg} = \frac{total\ distance}{\Delta t} = \frac{D_{up} + D_{down}}{\Delta t_{up} + \Delta t_{down}} = \frac{D_{up} + D_{down}}{\frac{D_{up}}{v_{up}} + \frac{D_{down}}{v_{down}}}$$

$$= \frac{D + D}{\frac{D}{v_{up}} + \frac{D}{v_{down}}} = \frac{2}{\frac{1}{v_{up}} + \frac{1}{v_{down}}} = \frac{2v_{up}v_{down}}{v_{up} + v_{down}}$$

$$= \frac{2(40)(60)}{40 + 60} = 48\ \mathrm{km/h}.$$

••21 From $t = 0$ to $t = 5.00$ min, a man stands still, and from $t = 5.00$ min to $t = 10.0$ min, he walks briskly in a straight line at a constant speed of 2.20 m/s. What are (a) his average velocity v_{avg} and (b) his average acceleration a_{avg} in the time interval 2.00 min to 8.00 min? What are (c) v_{avg} and (d) a_{avg} in the time interval 3.00 min to 9.00 min?

a)

$$x_2 = (2.20)(480 - 300) = 396 \text{ m}.$$

$$v_{avg} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{396 \text{ m} - 0}{480 \text{ s} - 120 \text{ s}} = 1.10 \text{ m/s}.$$

b)

$$a_{avg} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{2.20 \text{ m/s} - 0}{480 \text{ s} - 120 \text{ s}} = 6.11 \times 10^{-3} \text{ m/s}^2.$$

••21 From $t = 0$ to $t = 5.00$ min, a man stands still, and from $t = 5.00$ min to $t = 10.0$ min, he walks briskly in a straight line at a constant speed of 2.20 m/s. What are (a) his average velocity v_{avg} and (b) his average acceleration a_{avg} in the time interval 2.00 min to 8.00 min? What are (c) v_{avg} and (d) a_{avg} in the time interval 3.00 min to 9.00 min?

c)

$$x_2 = (2.20)(540 - 300) = 528 \text{ m}.$$

$$v_{avg} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{528 \text{ m} - 0}{540 \text{ s} - 180 \text{ s}} = 1.47 \text{ m/s}.$$

d)

$$a_{avg} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{2.20 \text{ m/s} - 0}{540 \text{ s} - 180 \text{ s}} = 6.11 \times 10^{-3} \text{ m/s}^2.$$

•29 ILW A certain elevator cab has a total run of 190 m and a maximum speed of 305 m/min, and it accelerates from rest and then back to rest at 1.22 m/s². (a) How far does the cab move while accelerating to full speed from rest? (b) How long does it take to make the nonstop 190 m run, starting and ending at rest?

a)

$$305\ \text{m/min} = 5.08\ \text{m/s}.$$

$$v^2 = v_0^2 + 2a\Delta x$$

$$\Delta x = \frac{v^2 - v_0^2}{2a} = \frac{(5.08\ \text{m/s})^2 - 0}{2(1.22\ \text{m/s}^2)} = 10.6\ \text{m}$$

•29 **ILW** A certain elevator cab has a total run of 190 m and a maximum speed of 305 m/min, and it accelerates from rest and then back to rest at 1.22 m/s^2. (a) How far does the cab move while accelerating to full speed from rest? (b) How long does it take to make the nonstop 190 m run, starting and ending at rest?

b) The elevator cab takes time t_1 to accelerate to the maximum speed, time $t_3 = t_1$ to decelerate to rest, and time t_2 moving at constant (max.) velocity.

$$t_1 = \frac{v - v_0}{a} = \frac{5.08\ \mathrm{m/s} - 0}{1.22\ \mathrm{m/s^2}} = 4.17\ \mathrm{s}.$$

The distance covered at constant velocity is $190\ \mathrm{m} - 2(10.6\ \mathrm{m}) = 169\ \mathrm{m}$. Thus,

$$t_2 = \frac{169\ \mathrm{m}}{5.08\ \mathrm{m/s}} = 33.2\ \mathrm{s}.$$

$$t_{\mathrm{total}} = 33.2\ \mathrm{s} + 2(4.17\ \mathrm{s}) = 41.5\ \mathrm{s}.$$

•49 SSM A hot-air balloon is ascending at the rate of 12 m/s and is 80 m above the ground when a package is dropped over the side. (a) How long does the package take to reach the ground? (b) With what speed does it hit the ground?

a)

$$y = y_0 + v_0 t - \frac{1}{2} g\, t^2$$

$$t = \frac{v_0 + \sqrt{v_0^2 - 2g(y - y_0)}}{g}$$

We discarted the negative root

$$= \frac{12\ \mathrm{m/s} + \sqrt{(12\ \mathrm{m/s})^2 - 2(9.8\ \mathrm{m/s^2})(0 - 80\ m)}}{9.8\ \mathrm{m/s^2}} = 5.45\ \mathrm{s}.$$

•49 SSM A hot-air balloon is ascending at the rate of 12 m/s and is 80 m above the ground when a package is dropped over the side. (a) How long does the package take to reach the ground? (b) With what speed does it hit the ground?

b)

$$v^2 = v_0^2 - 2g\Delta y$$

$$v = -\sqrt{v_0^2 - 2g(y - y_0)}$$

We discarted the positive root

$$= \sqrt{(12\ \text{m/s})^2 - 2(9.8\ \text{m/s}^2)(0 - 80\ \text{m})} = -41.4\ \text{m/s}.$$

••57 To test the quality of a tennis ball, you drop it onto the floor from a height of 4.00 m. It rebounds to a height of 2.00 m. If the ball is in contact with the floor for 12.0 ms, (a) what is the magnitude of its average acceleration during that contact and (b) is the average acceleration up or down?

a)

$$a_{avg} = \frac{v_2 - v_1}{t_2 - t_1}$$

Using $v^2 = v_0^2 - 2g(y - y_0)$,

b = before, a = after

$$v_1 = v_b = -\sqrt{v_{0,b}^2 - 2g\left(y_b - y_{0,b}\right)} = -\sqrt{0 - 2(9.8\ \mathrm{m/s^2})(0 - 4.00\ \mathrm{m})} = -8.85\ \mathrm{m/s}.$$

$$v_2 = v_{0a} = \sqrt{v_a^2 + 2g\left(y_a - y_{0,a}\right)} = \sqrt{0 + 2(9.8\ \mathrm{m/s^2})(2.00\ \mathrm{m} - 0)} = 6.26\mathrm{m/s}.$$

••57 To test the quality of a tennis ball, you drop it onto the floor from a height of 4.00 m. It rebounds to a height of 2.00 m. If the ball is in contact with the floor for 12.0 ms, (a) what is the magnitude of its average acceleration during that contact and (b) is the average acceleration up or down?

$$a_{avg} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{6.26\ \mathrm{m/s} - (-8.85\ \mathrm{m/s})}{12.0 \times 10^{-3}\ \mathrm{s}} = 1.26 \times 10^3\ \mathrm{m/s^2}$$

b) Up.

••58 An object falls a distance h from rest. If it travels $0.50h$ in the last 1.00 s, find (a) the time and (b) the height of its fall. (c) Explain the physically unacceptable solution of the quadratic equation in t that you obtain.

a)

The object falls by $h/2$ in time t_1 and by h in time $t_1 + 1.00$ s. v_0 is zero in both cases. We thus write

$$\frac{h}{2} - h = -\frac{1}{2}gt_1^2 \Rightarrow h = gt_1^2 \quad (1)$$

$$0 - h = -\frac{1}{2}g(t_1 + 1)^2 \Rightarrow h = \frac{1}{2}g(t_1 + 1)^2 \quad (2)$$

••58 An object falls a distance h from rest. If it travels $0.50h$ in the last 1.00 s, find (a) the time and (b) the height of its fall. (c) Explain the physically unacceptable solution of the quadratic equation in t that you obtain.

a) Solving for t_1 and h gives $t_1 = 1 \pm \sqrt{2}$. Discarding the negative, unphysical root we obtains $t_1 = 1 + \sqrt{2} = 2.41$ s. The total fall time t_{tot} is thus $t_1 + 1.00\text{ s} = 3.41$ s.

b) Substituting with $t_1 = 1 + \sqrt{2}$ gives

$$h = \left(3 + 2\sqrt{2}\right)g = 57.1\text{ m}.$$

c) See above.

••68 A salamander of the genus *Hydromantes* captures prey by launching its tongue as a projectile: The skeletal part of the tongue is shot forward, unfolding the rest of the tongue, until the outer portion lands on the prey, sticking to it. Figure 2-36 shows the acceleration magnitude a versus time t for the acceleration phase of the launch in a typical situation. The indicated accelerations are $a_2 = 400$ m/s^2 and $a_1 = 100$ m/s^2. What is the outward speed of the tongue at the end of the acceleration phase?

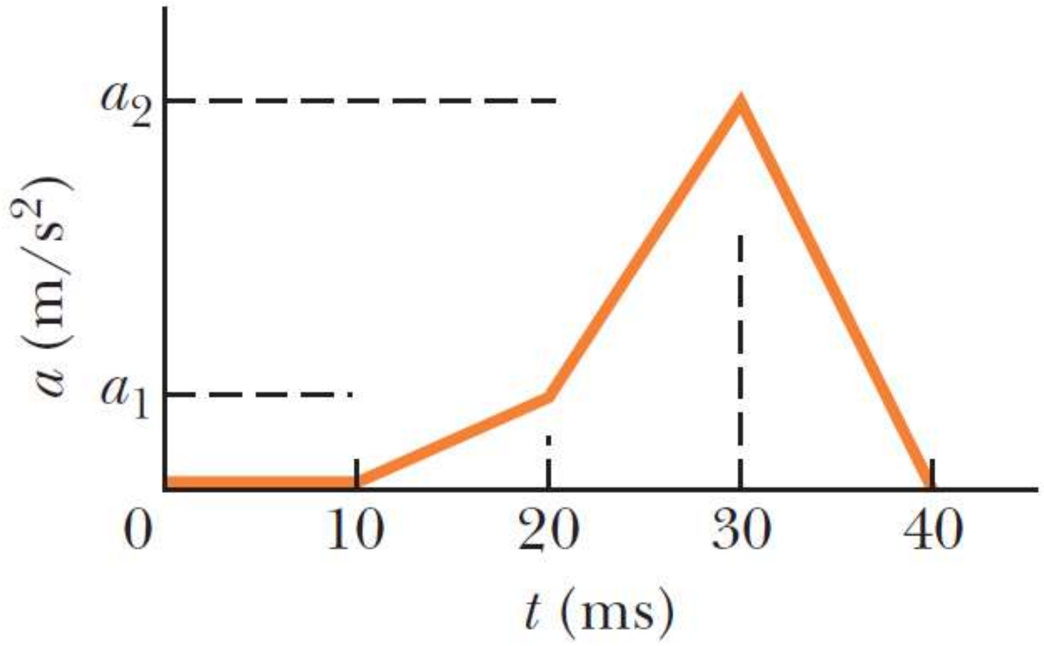

Fig. 2-36 Problem 68.

https://www.youtube.com/watch?v=6AeuGBXa7_o

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\begin{aligned}
\Delta v = \int_0^{0.040\ \mathrm{s}} a\,dt &= \text{the area under the } a(t) \text{ curve} \\
&= \frac{1}{2}(0.020\ \mathrm{s} - 0.010\ \mathrm{s})(100\ \mathrm{m/s^2}) \\
&\quad + (0.030\ \mathrm{s} - 0.020\ \mathrm{s})\left(\frac{400\ \mathrm{m/s^2} + 100\ \mathrm{m/s^2}}{2}\right) \\
&\quad + \frac{1}{2}(0.040\ \mathrm{s} - 0.030\ \mathrm{s})(400\ \mathrm{m/s^2}) \\
&= 5.0\ \mathrm{m/s}
\end{aligned}
$$